Patterns of achievement-motivated behavior and performance as predictors for future success in rowing: A person-oriented study

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Accepted manuscript

Please cite this article as:
Schmid, M. J., Conzelmann, A., & Zuber, C. (2021). Patterns of achievement-motivated behavior and performance as predictors for future success in rowing: A person-oriented study. *International Journal of Sports Science & Coaching, 16*(1), 101–109.
https://doi.org/10.1177/1747954120953658

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Abstract

Talent selection in rowing is often solely based on anthropometric and performance variables, even though psychological characteristics are considered to be important contributors to successful talent development. Because multidimensional talent models and holistic theories represent the state-of-the-art in talent research, we aimed to find patterns connecting psychological and performance variables to future success in rowing. Therefore, 22 coaches rated the achievement-motivated behavior represented by the variables proactivity, ambition and commitment of 65 competitive to high-level athletes (M_{age} = 17.2 ± 1.55 years) for the past year (t_1). Additionally, the athletes performed several 2,000m ergometer tests during that same period. At t_2 (30 months later), each rower's performance was evaluated based on the success at different competitions. To examine the results, we used the person-oriented Linking of Clusters after removal of a Residue (LICUR) method to identify the relationships between the achievement-motivated behavior and ergometer results at t_1 and the success at t_2. The rowers could be assigned to five clusters. Although the *highly motivated rowers* were not the fastest on the ergometer at t_1, they were more likely to be in highest performance level at t_2 compared to the other clusters (OR = 3.5, $p < .05$). By contrast, all the *ambitionless rowers* and *unmotivated rowers* were either racing at national level or had dropped out. In conclusion, certain patterns of achievement-motivated behavior and current performance are associated with future success (30 months later). The consideration of achievement-motivated behavior in the selection of rowers seems promising in this context.

Keywords: athletic performance, forecasting, pattern analysis, water sports, talent selection

Introduction

Rowing is considered to be a highly demanding sport both physically and mentally, as evidenced by the fact that rowers show the highest recorded physiological attributes (e.g., VO_{2max}) among athletes of any sport.[1,2] With an Olympic distance of 2,000m and race duration between 5 minutes 20 seconds and 8 minutes, rowing is considered a high-intensity sport.[3] Therefore, rowers must be prepared to deal with exercise-induced pain during training and competition.[4]

Reaching the highest international level requires the athlete to train for around ten years: Statistically, world-class performers began rowing at the age of 15 ± 2 years and won their first gold medal at the World Rowing Championships or the Olympic Games between the ages of 24 and 28 years.[5] The average training volume of internationally successful rowers is between 1,100 and 1,200h per year,[5] a regimen that is crucial to developing and increasing the aerobic and anaerobic capacity.[6] Rowers need specific motor skills in order to balance the boat [7] and to coordinate their movements within their crew.[8,9] Specific anthropometric characteristics such as large body dimensions and low body fat help to achieve top-level performance.[10–14] There are also several physiological attributes (e.g., power at the anaerobic threshold intensity or VO_{2max}) that can help to predict future success in rowing.[15–18] Therefore, many clubs and federations choose their talents on the basis of the current performance and anthropometric characteristics.

Besides physiology, anthropometry and motor skills, several psychological aspects are discussed in literature; however, they are rarely applied for talent selection in rowing. These include regulation of stress and recovery skills,[19,20] mood regulation,[21] personality,[22] communication with other crew members and coaches,[19,23] mental imagery,[24] the appropriate use of attentional strategies,[4,25,26] appraisal style,[27] and motivational factors.[21,28]

Findings from other sports suggest that several motivational constructs (e.g., achievement motivation, achievement goal orientation, self-determination) are relevant for talent development and later success.[29–34] This is also in line with the assessment of several rowing coaches, who consider motivational factors to be very important for successful talent development.[35] For example, rowers have to be very motivated in order to handle the high volume and intensities in everyday training over many years.[5]

However, in rowing only one study has been conducted on the importance of motivational constructs in the selection process. Raglin et al.[21] have focused on the construct of self-motivation, which is defined as the tendency to engage in a behavior independent of extrinsic reinforcement[36]. They found a negative correlation between self-motivation and the dropout rate among 64 female collegiate freshman rowers.[21] The lower the self-motivation, the higher the probability that the rowers dropped out of training. In addition, a significant correlation of $r = -.47$ was found between rowing ergometer performance (time) and self-motivation.[21] Because of the low performance level of these athletes (beginners) and the short observation period (seven months) in this study, the role of motivation for performance in high-level rowing remains unclear. In addition, the direct measurement of motivation is afflicted with some problems in the practical process of talent selection, because it is not directly observable, and self-reports can be distorted to favor socially desirable answers (e.g., the tendency to provide answers that increase the chance to get selected).[37]

Talent research from a person-oriented perspective

It is frequently highlighted in current research that for reliable talent identification and selection, the various performance-determining factors should be combined into a multidimensional investigation approach.[38–40] One methodological possibility to combine different dimensions is the person-oriented approach,[41,42] which has previously been successfully applied in the talent research.[33,43,31,44,45] In the person-oriented approach, "the individual is regarded as a dynamic system of interwoven components that is best understood in terms of whole-system properties and often best studied by methods that retain these properties as far as possible, such as those that focus on individual patterns of information" (p. 155).[41] The focus of this approach is on individuals instead of variables, which fits very well within talent selection and has several advantages. Thus, non-linear and reciprocal interactions between single characteristics within each individual may taken into account.[45] Thus, athletes compensating their own weaknesses (e.g., average physical fitness) through their strengths (e.g., outstanding technical skills) could be identified by this method. However, mapping the overall human-environment system is very complex and methodologically hardly feasible. Therefore, the overall system is often divided into various subsystems.[43] This allows the subsystems to be examined in a greater degree of detail.[44]

The present research

In order to address the aforementioned gap in research, we aimed to investigate whether considering the interaction between motivational variables and performance is advantageous for predicting the future success of high-level junior and under-23 rowers. To solve the problem with the socially desirable answers from athletes in selection processes, Zuber and Conzelmann[46] propose the assessment of the achievement-motivated behavior instead of explicit or implicit achievement motives, because it is directly observable and not very resource-consuming (cf. projective tests). The authors define the achievement-motivated behavior "as self-determined behavior in the context of competitive sports, which aims to achieve competition- or task-oriented goals and which involves a high degree of self-regulation and commitment" (p. 17).[47] The idea of measuring behavior instead of self-reports is also consistent with proposals from other authors.[48,49] Therefore, we chose achievement-motivated behavior as the motivational indicator in this study. As it is the first study combining achievement-motivated behavior and performance to form patterns, the profiles of patterns could not be anticipated.

The following research questions will guide the following analysis:

(1) Which patterns are detectable in young rowers based on achievement-motivated behavior and performance?
(2) Are there certain patterns associated with success 30 months later?

Methods

Participants

We recruited twenty-two rowing coaches (18.2% women) through the Swiss Rowing Federation. Two coaches were employees from the Swiss Rowing Federation, whereas 20 coaches were working for different rowing clubs in Switzerland. They had an average coaching experience of 14.55 years (*SD* = 11.03, *range* = 1–33). The average age of the coaches was M_{age} = 41.27 years (*SD* = 11.42, *range* = 20–61). We recruited the athletes with the help of these coaches. In total 65 athletes (29.2% women) with an average age of M_{age} = 17.2 years (*SD* = 1.55, *range* = 14–21) and average rowing experience of $M_{exp.}$ = 4.82 years (*SD* = 1.53, *range* = 2.33–8) took part our study.

At t_1, all athletes were competing at least on a national level. Up to the second measurement point (t_2; 30 months later), several athletes had won a World Rowing Junior or Under-23 Championship medal. In the FTEM (Foundations, Talent, Elite, Mastery) classification this would correspond to levels T2 to E1.[50]

Measures

We assessed the achievement-motivated behavior of athletes with the *AMBIS-I* (**A**chievement-**M**otivated **B**ehavior in **I**ndividual **S**ports) coach-rating scale.[46] It consists of ten prototypical behaviors where the frequency of occurrence is estimated on a 4-point scale from 1 (= never) to 4 (= always). The coach rated each athlete individually on the basis of the behavior displayed in the past 12 months. The evaluations center around the three factors proactivity (e.g., “He/she stayed after training to continue practicing”), ambition (e.g., “He/she has shown that he/she is not satisfied with 2nd place”) and commitment (e.g., “In high demanding exercises, he/she worked until exhaustion”).[46] We also asked the coaches how certain they felt about their assessment of the athlete (*not at all*, *a little*, *somewhat*, *fairly much*), about theirs job/coach position, and how many years they had already known the assessed athletes. *AMBIS-I* was tested for criterion and construct validity (e.g., comparison with well-established questionnaires) and showed acceptable values (see Zuber et al.[47]).

Rowing performance tests are usually done by rowing over different distances in the boat on the water or on the ergometer. Because the on-water testing is “very noisy” due to varying environments and consequently difficult to standardize, Smith and Hopkins[3] propose the Concept2 ergometer (Morrisville, Vermont, USA) for individual performance testing in rowing. Even though rowing on the ergometer does not recruit the same skills as rowing in the boat (e.g., balance, timing, blade work), a rowing ergometer can simulate the biomechanical and physiological demands of on-water rowing.[3,51] The standard test on the ergometer is the 2,000m maximal test, which shows a high retest reliability of r_{tt} = .96[52] and a moderate-to-strong criterion-related validity of r_{tc} = .50 to .78 to the on-water performance.[53] For those reasons, we chose the Concept2 ergometer as performance testing tool in this study. To enable comparison of the ergometer results across different categories (e.g., age, gender), we represented the individual performances as percentages of the “Swiss Rowing Gold Standard Times 2017”. These times are based on the world records of each category, which means that a 100% performance of an athlete equals the world record in the corresponding category. The use of such “prognostic speeds” is a common practice in rowing for the evaluation of training and competition results.[3]

To assess the performance level at t_2, we checked whether the athletes a) were selected for major international elite rowing events (World Rowing Championships, European Rowing Championships or World Rowing Cups) or achieved a top ten placement at the World Rowing Junior or Under-23 Championships in that summer, b) were racing on a national level or had dropped out.

Procedures

We used a longitudinal multi-method research design to predict the success of the athletes through the achievement-motivated behavior and the rowing performance. In order to get more valid assessments of our relatively homogenous sample all variables were measured in representative context over a relatively long period of time (see achievement-motivated behavior) or through repeated measurements (see 2,000m test).[54] At the first measurement point (t_1), the coaches were asked to rate the achievement-motivated behavior over the past year of their athletes who were younger than 22 years old. Seventy percent of all coaches rated between one and three athletes, one coach rated nine athletes. Those coaches have known their athletes for M = 2.92 years on average (SD = 1.66, *range* = 1–7). We collected the data of the coaches' ratings through an internet-based questionnaire (LimeSurvey, Version 2.50). To determine the initial rowing performance of the athletes, the Swiss Rowing Federation provided us with all ergometer results between December and September of the previous year. We used for each athlete only the personal best time during this period for the analysis. Thirty months after t_1, we evaluated the performance level of all the participating athletes based on their current rowing results. Formal ethical approval was granted from the authors' institutional review board before conducting the study.

Data processing

Some athletes (n = 16) were assessed through two coaches (e.g., head coach and assistant coach), but only one assessment was used. We applied the following criteria to choose the final assessment: 1) Certainty of the coach during the assessment, 2) job/coach position 3) duration of the working relationship between coach and athlete. There were 4% missing values in the assessment of achievement-motivated behavior and no missing values in the ergometer test results as only athletes who performed a test the season of 2016 were considered for the study. The missing values were imputed through the Expectation-Maximization (EM) algorithm as Little's MCAR was non-significant ($\chi^2 = 335.88$, $df = 326$, $p = .32$).

Data analysis

In order to analyze pattern within the person-oriented approach, the Linking of Clusters after removal of a Residue (LICUR) is viewed as one appropriate method.[55] The goal of this method is to form clusters (patterns) on the basis of operating factors (e.g., test results) and to map the developmental process through the individual transitions. In the first step, a residual analysis is done in order to find individuals with unusual and therefore rarely occurring patterns. Because outliers can substantially influence the result of cluster analysis, these extreme cases should be removed. The criterion for the removal of an outlier was that its dissimilarity to all other subjects would exceed 0.7, as measured by the squared average Euclidean distance calculated on standardized variables.

In a second step, a hierarchical cluster analysis is performed. For the current analysis, we chose Ward's method with the average squared Euclidean distance measure. We used theoretical meaningfulness of the cluster structure and statistical criteria to determine the optimal cluster solution. The following statistical characteristics were taken into account: (a) elbow criterion; (b) homogeneity coefficient ($HC_{mean} < 1.0$); (c) the size of explained error sum of square (EESS% > 67%); and (d) silhouette coefficient (SC > 0.5).[56,55] Through a cluster center analysis (k-means method) the cluster solution was optimized.

In a third step, the similarity between the clusters of the different phases or specific developmental outcome can be determined. We checked all the paths for significant deviations from random deviations using Fisher's exact test, with a hypergeometric distribution ($p < .05$). The odds ratio (OR) shows the amount to which the probability of significant path is either increased (OR > 1.0) or decreased (OR < 1.0). In the case of zero events, the Peto odds ratio (POR) will be calculated.[57] Furthermore, we performed a one-way ANOVA to test any cluster differences in years of training and performance level. The gender distribution across the clusters was checked with a Fisher's exact test. For all statistical tests a significance level of $p < .05$ was chosen. Eta-square (η^2) was reported as an estimate of the effect size (0.01 = small, 0.06 = medium, 0.14 = large).[58] The LICUR analysis was performed with the statistics package ROPstat 2.0,[59] all other analysis were done with IBM SPSS Statistics (Version 25.0).[60]

Results

The descriptive statistics of the three factors of the achievement-motivated behavior and the percentages of the rowing ergometer performance before *z*-standardization are presented in Table 1. Commitment was displayed most frequently, followed by ambition and proactivity. Compared with the other two factors commitment shows a restricted variance, which may be due to a ceiling effect. The Cronbach's α varies between .67 (commitment) and .78 (proactivity). In view of the relative brevity of the scales and the homogeneous sample, it can be described as acceptable.[61,62] The mean ergometer performance is 86.44% (SD = 5.09) of the "Swiss Rowing Gold Standard Times 2017".

Table 1. Descriptive statistics and Cronbach's α of the operating factors at t_1.

	t_1 (*n* = 65)							
	M	***Mdn***	***SD***	***IQR***	***Min.***	***Max.***	***Number of Items***	***Cronbach's α***
Proactivity	2.54	2.75	0.76	1.34	1.00	3.75	4	.78
Ambition	3.05	3.00	0.74	1.00	1.33	4.00	3	.76
Commitment	3.49	3.67	0.51	0.83	2.00	4.00	3	.67
Ergometer performance (%)	86.44	86.32	5.09	6.95	74.56	96.17	–	–

Note: Scale *AMBIS-I*: 1–4

Clusters

We compared the *z*-standardized patterns of all individuals in pairs with the average squared Euclidean distance as a measure of similarity. With a threshold of 0.7 no outliers were identified in the current data set.[55] The subsequent cluster analysis revealed a 5-cluster solution (Figure 1) using the criteria by Bergman et al.[55] and Vargha et al.[56] as well as content aspects. The final solution shows an explained error sum of squares (EESS) of 59.2% and a mean homogeneity coefficient (HC_{mean}) of 0.87 and the silhouette coefficient (SC = 0.61) at t_1. Although the desirable 2/3 criterion of the EESS was not fully met, the two other coefficients reached sufficient values.[55,56,59]

In Figure 1, the means of the factors are shown as *z*-standardized scores. Only those motivational factors with *z*-scores > |0.7| were used to name the different clusters. The *highly motivated rowers* (cluster 2) show the highest scores on the three factors of the achievement-motivated behavior, whereas the *unmotivated rowers* (cluster 4) display the lowest scores on the three factors of *AMBIS-I.* The *uncommitted rowers* (cluster 5) have the best ergometer performance (89.95%) and *ambitionless rowers* (cluster 1) the lowest ergometer performance (81.17%). Apart from the factor proactivity, the *reactive rowers* (cluster 3) show in all other factors relatively high values. A one-way ANOVA showed significant ergometer performance differences among the five clusters ($F(4,60) = 14.48$, $p < .01$, $\eta^2 = 0.49$). Post-hoc tests (Bonferroni) exhibited no statistic significant difference ($p > .05$) in the ergometer performance between cluster 2, 3 and 5 at t_1. Only cluster 1 and cluster 4 showed both a significant lower performance ($p < .05$) at t_1 (see Table 2). There was no difference between the clusters regarding the years of training in rowing ($F(4,60) = 1.39$, $p = .25$, $\eta^2 = 0.09$) and gender ($p = .56$).

Table 2. Descriptive statistics of the five clusters with the operating factors at t_1.

t_1 (n = 65)	Proactivity				Ambition				Commitment				Ergometer performance (%)			
	M	***Mdn***	***SD***	***IQR***	***M***	***Mdn***	***SD***	***IQR***	***M***	***Mdn***	***SD***	***IQR***	***M***	***Mdn***	***SD***	***IQR***
Cluster 1: *Ambitionless rowers* *n* = 15	2.36	2.5	0.66	0.93	2.38	2.33	0.48	0.67	3.72	3.67	0.21	0.33	81.17	81.28	4.45	8.04
Cluster 2: *Highly motivated rowers* *n* = 20	3.22	3.34	0.41	0.70	3.56	3.67	0.50	0.94	3.90	4.00	0.16	0.33	89.74	90.13	3.45	5.09
Cluster 3: *Reactive rowers* *n* = 12	1.85	1.75	0.35	0.67	3.30	3.21	0.49	0.67	3.53	3.50	0.36	0.58	86.94	86.92	3.53	3.93
Cluster 4: *Unmotivated rowers* *n* = 9	1.78	1.75	0.61	1.00	2.33	2.67	0.76	1.50	2.67	2.67	0.33	0.50	83.72	83.47	3.55	4.22
Cluster 5: *Uncommitted rowers* *n* = 9	3.03	3.00	0.26	0.50	3.41	3.33	0.40	0.83	3.00	3.00	0.37	0.67	89.95	90.01	3.56	5.38

ANOVA main effect performance ($F(4,60) = 14.48$, $p < .01$, $\eta^2 = 0.49$); sig. Bonferroni-tests: performance: (2), (3), (5) > (1), (4)

Transition analysis

We found three increased and three decreased odds between the clusters at t_1 and the performance level t_2. All of the *ambitionless rowers* (cluster 1; OR = 6.35, [1.84; 21.96], $p < .05$) and *unmotivated rowers* (cluster 4; OR = 5.21, [1.15; 23.67], $p < .05$) were either racing only at national level or had dropped out at t_2. Whereas the majority of the *highly motivated rowers* (cluster 2; OR = 3.5, [1.14; 10.76], $p < .05$) were either placed top ten at World Rowing Junior/Under-23 Championships or racing at major international elite rowing events in that year.

The three decreased odds were found from the *ambitionless rowers* (cluster 1) to the international success level (OR = 0.16, [0.05; 0.54], $p < .05$), from the *highly motivated rowers* (cluster 2) to the national level/dropout (OR = 0.29, [0.09; 0.88], $p < .05$), and from the *unmotivated rowers* (cluster 4) to the national level/dropout (OR = 0.19, [0.04; 0.87], $p < .05$). All the other clusters exhibit no significant transitions.

[Figure 1 near here]

Discussion

Currently there is a clear overrepresentation of studies that examine the physical profiles of athletes in rowing (e.g., Kerr et al.[10]), a trend that can be found in other sports too (e.g., soccer, handball, rugby).[63] The present study offers insights into the role of achievement-motivated behavior in rowing. The results suggest that certain patterns of achievement-motivated behavior and performance are associated with future success in rowing and display the potential usefulness of psychological factors within a talent identification and selection process.

The study at hand is the first to use the person-oriented approach combining motivational and performance variables in order to predict future success in rowing. The advantage of this approach is that individual patterns and compensation effects between different variables are taken into account instead of comparing all athletes across the same static performance metrics (such as 2,000m times).[31,44,64] For example, smaller athletes with a good rowing technique or a high motivation may compensate for their anthropometric disadvantages.

In applying this approach, we conducted a cluster analysis and found five clusters with six significant transitions to the performance criteria. The positive connection between achievement-motivated behavior and future success is in accordance with previous study results, which examined (achievement) motivation in sport.[29,30] At t_1, the *uncommitted rower*s show the best performance on the rowing ergometer (89.95%), yet they were not more likely to be in the highest performance level at t_2. It can be hypothesized that athletes with strong achievement-motivated behavior are more willing to train intensively and regularly than those with low achievement-motivated behavior. This would explain why the *highly motived rowers* were more likely to be successful at international competitions. Neither the *unmotivated rowers* nor the *ambitionless rowers* were found in the highest performance level, but their performance at t_1 was already at a lower level. For coaches and practitioners who are involved in talent selection, it is interesting to know that athletes with the same level of performance can be differentiated based on their achievement-motivated behavior. Compared to other motivational constructs (e.g., self-determination), achievement-motivated behavior has the advantage that it is directly observable and does not have to be measured by self-reports of the athletes (problem of socially desirable answers)[46].

The results of this person-oriented study go in the same direction as the variable-oriented study of Raglin et al.[21], who found a negative correlation between self-motivation and dropout rate in rowing. The present study was able to find patterns of achievement-motivated behavior and performance that are associated with later selection failure or dropout. Because Raglin et al.[21] conducted his study with female collegiate freshman rowers, the inclusion of several World Rowing Junior or Under-23 Champions in the dataset is certainly a valuable asset to the present study.

This study is limited in a number of dimensions. First, the athlete population in Swiss rowing is small and *AMBIS-I* is only available in German, which limits the number of athletes suitable for the study and resulted in a relatively small sample size (n = 65). Second, the sample is highly selective and the variance among the athletes was relatively small (see ergometer results). For example, an *unmotivated rower* might be considered highly motivated when compared to an average person the same age. Therefore, the conclusions are only valid for competitive sports. Third, although possible self-rating biases are eliminated with the coach-rating scale *AMBIS-I*, answering tendencies from the assessor (coach) are *still* possible. However, in the study of Zuber et al.[47] the inter-rater reliabilities lie within an acceptable range, which would speaks against answering tendencies of individual coaches. Fourth, the study length of two and a half years is rather short and should be extended for future research projects. For example, interesting performance measures extending into the future would include the qualification for major international competitions at elite level such as the Olympic Games or World Rowing Championships. Fifth, multidimensional designs are proposed by different authors[39,40,38] and this study takes a step into this direction with the two variables examined. Nevertheless, a strictly holistic approach would consider more variables associated with success in rowing (e.g., amount of training, anthropometric or environmental variables). Hence, future research using a person-oriented approach in rowing should aim to broaden the set of variables, the number of measurement points and the sample size.

It has been mentioned above that *reactive* and *uncommitted rowers* are on the same initial performance level as the *highly motivated rowers*, but they do not participate as much in major international competitions. From a talent development perspective, it would be interesting to know whether these athletes should be treated differently depending on their achievement-motivated behavior. For example, *reactive rowers* might benefit more from a close monitoring by the coach, whereas *uncommitted rowers* may benefit from additional psychological skills training (e.g., goal setting)[65]. Furthermore, it would be interesting as well to examine if there is a connection between a high achievement-motivated behavior and negative consequences such as sport related injuries, overtraining or illnesses during the training process.

In conclusion, there is an association between patterns of achievement-motivated behavior and performance with future success in rowing. Therefore, it is beneficial to select rowers not only based on performance results, but rather to use a multidimensional talent identification and selection program considering also achievement-motivated behavior. Through multidimensional talent selection, compensation possibilities between the different criteria are taken into account, which ensures better chances for athletes with high performance potential.[38–40]

Acknowledgement

We would like to thank Swiss Olympic and the Swiss Rowing Federation for funding and supporting this research project. Additionally, we want to acknowledge Nina Schorno for her help with data gathering. No conflict of interest is present for any aspect of this study.

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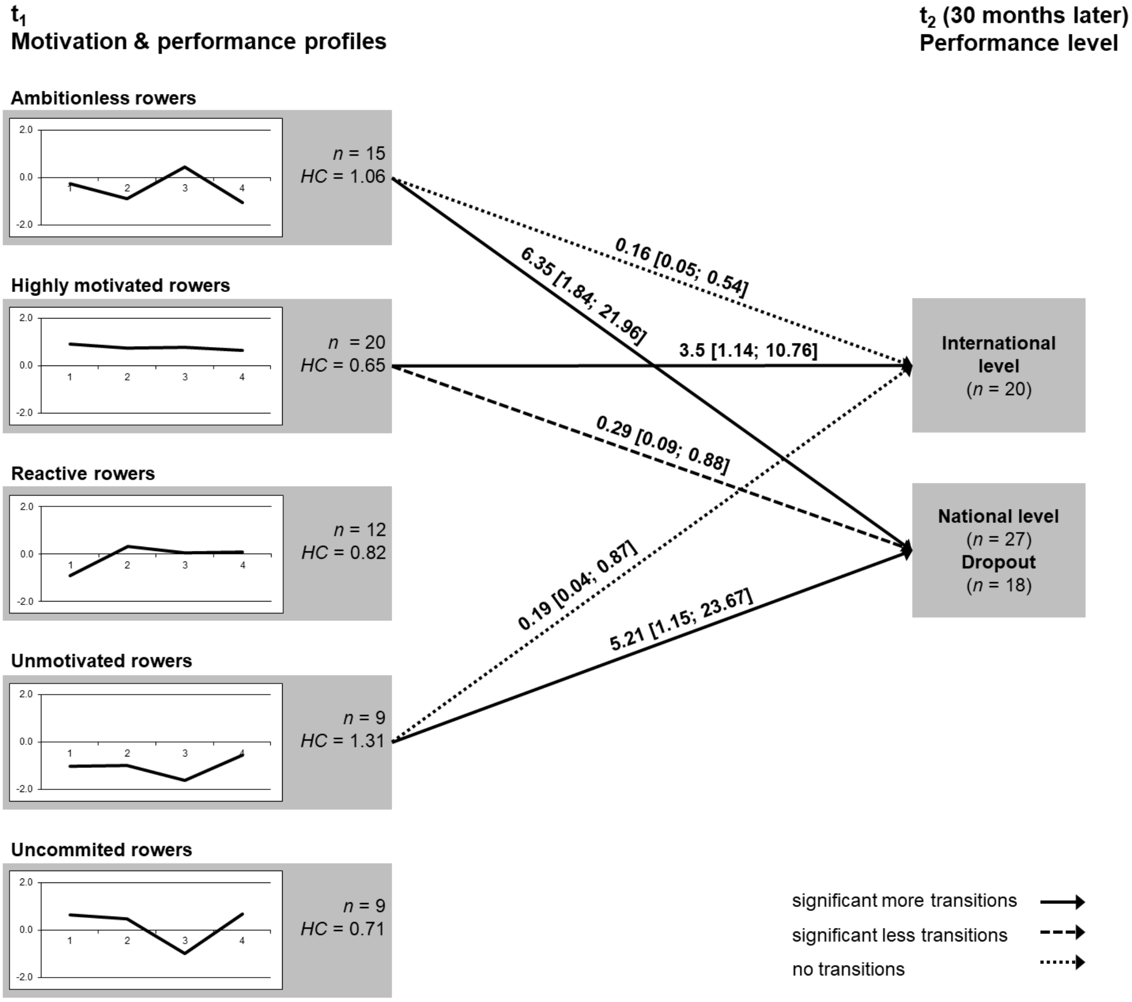

Note. Operating factors: 1 = Proactivity; 2 = Ambition; 3 = Commitment; 4 = 2,000 m ergometer best time of the previous 12 months. Performance level: 1 = international level (top ten at World Rowing Junior/Under-23 Championships or selection for major international elite rowing events); 2 = national level or dropout. The numbers next to the arrows represent the odds ratios and 95% confidence intervals (significant more transitions: OR > 1.0; significant less transitions: OR < 1.0). *HC* = Homogeneity coefficient (mean square Euclidian distance within the cluster). Cluster differences: Performance level ($F(4,60) = 14.48$, $p < .01$, $\eta^2 = 0.49$); sig. Bonferroni-tests: performance: Cluster (2), (3), (5) > (1), (4); years of training in rowing ($F(4,60) = 1.39$, $p = .25$, $\eta^2 = 0.09$); gender ($p = .56$).

Figure 1. z-score profiles of the five clusters and transitions to the performance levels.